Forest Site Management Section

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SILVICULTURE NOTE 23

ROOT DEVELOPMENT OF 12 YEAR OLD WHITE SPRUCE GROWING ON MINERAL-CAPPED INVERTED MOUNDS AND UNTREATED GROUND IN THE BWBS ZONE OF NORTHERN BC

Summary

Root systems of 12 year old white spruce were excavated from mineral-capped inverted mounds (Figure 1) and compared with those growing in untreated ground (control) to determine whether they were developing root systems of adequate size and structure to support the maturing tree. Mound seedlings were larger than seedlings growing in the untreated control and their root systems were also proportionally larger. Mound seedlings had more, and larger, structural roots (main laterals) than control seedlings, and had a greater number of roots of all sizes. Roots were distributed as evenly around the stems of mound and control seedlings. The average depth of main lateral roots (3–5 cm) and their average spread from the stem (150 cm) were similar among seedlings on mounds and in the untreated control. Roots of mound seedlings readily egressed beyond the mound environment, except where mounds were located in hygric depressions.

Figure 1. Twelve year old white spruce root system excavated from a mineral-capped inverted mound.

Introduction

The effectiveness of mechanical site preparation for improving early seedling performance in north and north-central BC has been demonstrated by numerous studies. Inverted mineral mounds have proven particularly useful for ameliorating the effects of cold, wet soil and dense brush that are common to many northern ecosystems. However, most research has concentrated on shoot development and monitoring has tended to continue for no more than a decade after planting. The purpose of this study was to determine whether seedlings planted in prepared ground developed root systems of appropriate size and architecture to support the maturing trees.

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This note presents the results of a root excavation study undertaken to determine whether 12 year old white spruce (*Picea glauca*) seedlings planted on inverted mineral mounds were developing adequate root systems in comparison with seedlings in an untreated control. Excavations were carried out in summer 1996, using seedlings that were part of a previously established site preparation trial near Wonowon, BC.

About the Site

The Wonowon research site is approximately 85 km north of Fort St. John, BC, at an elevation of 900 m in the BWBSmw1 (Peace variant of the moist warm Boreal White and Black Spruce zone). The site is on a very gentle slope (0–5%), facing N to NE. Soils are silt-loam textured Brunisols and Grey Luvisols, with low coarse fragment content and a compacted B horizon at 15–30 cm. The soil moisture regime is subhygric-mesic in flat and convex areas, and hygric in depressions. The site was clearcut logged in 1977 and the original site preparation trial was established in the mid-1980s.

Methods

Two treatments (untreated control and inverted mounds similar in size and structure to excavator mounds) were selected from the original site preparation trial as representative of the most common treatments in the BWBS zone. Twenty-five seedlings were excavated from each treatment. Root systems of mound seedlings were excavated within the mound perimeter, and those of control seedlings were excavated within a similarly sized 50 cm control radius around the stem. Prior to excavation, each spruce seedling was measured for height, height increment, root collar diameter, and crown diameter. Root systems were assessed for number of main lateral roots (structural roots), diameter of main laterals at 10 cm intervals from the stem, and the total number, diameter, and total cross-sectional area of all roots exiting the mound and the 50 cm control radius.

Results

Seedling shoots

At age 12, spruce seedlings on mounds were 35% taller than those in the untreated control (231 cm vs. 171 cm, Figure 2a). Mound seedlings also had 69% larger root collar diameters (4.4 cm vs. 2.6 cm, Figure 2b) and 40% larger crown diameters (120 cm vs. 86 cm) than control seedlings. There were no differences in height increment (average 29 cm). Eighty-eight percent of mound seedlings were of excellent or good vigour, compared to 37% of control seedlings.

Main lateral roots

Mound seedlings had an average of 4.5 main lateral roots, compared to an average of 3.0 among control seedlings (Figure 2c). Main laterals of mound seedlings were about 0.35 cm larger in diameter at each 10 cm interval (0–50 cm) from the stem. Main lateral roots of seedlings on both mounds and the control occurred at an average depth of 3–5 cm, but the substrate at that depth varied between the two treatments. As a result, the majority of main lateral roots of mound seedlings were growing in mineral soil in the mound cap, while those of control seedlings occurred almost equally in the forest floor and the upper few centimetres of mineral soil. Mound seedlings sometimes had two layers of main laterals, one near the surface of the mineral cap, and another at the interface of the mineral mound and humus layers.

Roots exiting the mound or 50 cm control radius

More roots of nearly all diameter classes exited mounds than exited the control radius. In total, an average of 34 roots (>1 mm) exited mounds compared to an average of 14 roots exiting the control radius. The cross-sectional area of roots exiting the mound or control radius (including main laterals), was five times greater for mound seedlings than control seedlings (Figure 2d). The overall distribution of roots exiting the mound or control radius was equally symmetric for both treatments.

Discussion

Root systems of 12 year old white spruce seedlings growing on mineral mounds had well-developed root systems that were as symmetrical as those growing in the control. Mound seedlings were larger than those in the control because of the improved conditions for early growth provided by the mound, but the root systems were also larger and above- and below-ground development appeared to be taking place proportionally. Roots of mound seedlings had egressed well beyond the mound environment by age 12, except for the few cases where the mounds were located in hygric depressions. Root systems of those seedlings were poorly developed, and did not egress beyond the mound environment, either dying at the edge of the mound or growing upward and laterally to avoid the wet soil conditions. Root systems of seedlings planted in hygric depressions in untreated ground were also very poorly developed.

The average rooting depth of 3–5 cm for main laterals was similar for seedlings on mounds and the control, even though substrates at that depth varied between

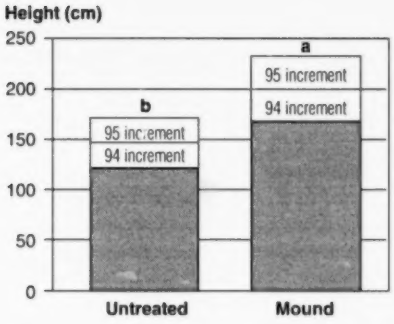

Figure 2a. Spruce height and height increment.

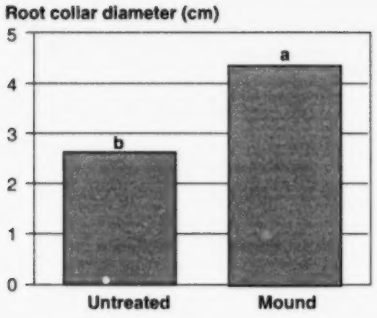

Figure 2b. Spruce root collar diameter.

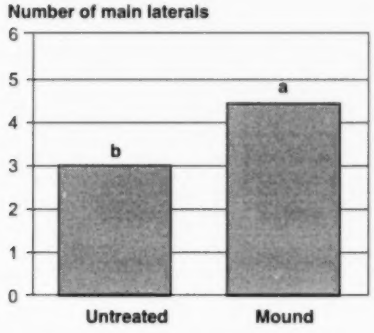

Figure 2c. Number of main lateral roots.

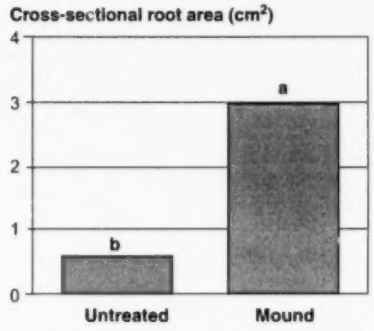

Figure 2d. Root cross-sectional area.

the two treatments. This suggests that rooting depth was controlled more by environmental factors such as soil temperature and moisture content than by substrate characteristics. Root development beyond the mound and 50 cm control radius was similar. Main lateral roots of seedlings in both treatments extended for a total distance of about 150 cm and grew at a depth of about 5 cm.

In the widespread BWBS zone of northern BC, the great majority of white spruce seedlings are planted on mechanically prepared mounds or in untreated ground. We compared the root systems of the two for the purpose of assessing the structural development of mound seedlings, mainly with regard to future stability. Characteristics such as root diameter, root symmetry, amount of branching, and the angle between main structural roots have been suggested as criteria for assessing the stability of root systems. According to all these criteria, seedlings planted on mounds are just as likely as seedlings planted in untreated ground to develop good root architecture that will ensure future stability. Full results of this study are reported by Heineman et al. (1999).

References

Heineman, J.L., L. Bedford, and D. Sword. 1999. Root system development of 12-year-old white spruce (*Picea glauca* (Moench) Voss) on a mounded subhygric-mesic site in northern interior British Columbia. For. Ecol. and Manage. 123: 167–177.

Acknowledgements

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